

ECONOMIC APPRAISAL OF ENDANGERED PLANT SPECIES

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"Die when I may, I want it said of me by those who know me best, that I plucked a thistle and planted a flower, wherever I thought a flower would grow."²

Asked to evaluate economically the candidate list for endangered and threatened plant species in the continental United States,³ I faced two problems, (1) paucity of economic data on endangered species, (2) difficulty in eliminating personal biases. The first problem was alleviated by taking a generic approach; the second, by objectively assigning two novices to the compilation. Mary Cepko and Janet Kluge are new to economic botany and had developed no biases. They were commissioned to compare the candidate species with a cosmopolitan useful plant list and a cosmopolitan weed list we had not used before.

First we alphabetized the list of genera with "listed" species. "listed" species, I define as a species among the proposed candidates for the threatened or endangered species lists.³ A "listed" genus, I define as a genus containing one or more "listed" species. Then we consulted Usher's A DICTIONARY OF PLANTS USED BY MAN⁵ and counted the useful species in each "listed" genus. This number, a crude index of the world's useful species in each genus, is recorded in Table 1. No nomenclatural or taxonomic judgments were made. If a useful species was listed under a "listed" genus, the useful species was counted. Then we consulted a composite world weed index compiled by Sandy Lyon and Anne Morehead⁶ by merging the WSSA Weed List (1971),⁷ C. R. Gunn's⁸ unpublished list of noxious weed seeds of the 50 States, John Dickson's⁹ unpublished list of tropical weeds in 8 different banana growing areas, and Clyde F. Reed's¹⁰ unpublished list of more than 1000 species of weeds endemic to the United States. The number of weed species in "listed" genera in this Composite List is also reported in Table 1. For example, Abutilon with a score of 12+ and 3- has 12 useful species in Usher, and 3 weed species in the Composite List. This might be further taken to indicate that this genus has more "virtues than vices," that it has a positive economic value. On the other hand, Agrimonia with 1 useful species and 1 weed species has a negative economic score.

An obscure species in a genus is more likely to share the economic potential of the genus as a whole, than that of another genus. Hence Table 1 objectively hints at the economic potential of a genus, and presence of an obscure listed species in that genus. If a species is obscure because of a relict or refugium distribution, it might be argued that it constitutes no weed threat in immediate geological time. However, if the limited distribution of an endangered species is due to recent evolution rather than gradual extinction, the species could have weed potential. Weeds cost America about 5 billion dollars per year. About 5% of the worst weeds in the United States are introduced species. At one time, these weeds also had a very limited distribution in the United

States. If their overseas population had not been known to the student of the American population, these first invaders might well have been classified as endangered species.

Three arguments have been raised for conservation of the "listed" species and I believe all have some merit. I list these in what I think is descending order of economic importance. (1) They could have (an unknown and unpredictable) economic potential in their germplasm (nearly 35% of the listed genera, e.g., have one or more species which have shown some activity in R. E. Perdue's¹¹ cancer screening program). (2) Species diversity makes an ecosystem more stable. (Diversity could be maintained in a given habitat by substituting a useful species for an endangered species with lesser economic potential. The Plant Taxonomy Laboratory is developing a system using non-endangered plant species as indicators of habitats suitable for endangered species). (3) The preservation of endangered species contributes to the preservation of a natural ecosystem. Are there any natural ecosystems? Are they better than artificial ecosystems? In whose eyes? For worse or better, some Americans prefer a lawn to a savanna, an orchard to a woodlot, and a pine plantation to a virgin forest. There are good reasons for maintaining all these habitats. But Man's introduced exotics have probably crept into nearly all habitats of the United States, so that the natural habitat is already tainted. Is it natural for man to preserve artificially a species that would have suffered extinction naturally? Is it natural for man to increase artificially the numbers of endangered species to the point that some unpredicted weed potential might be unleashed? Whether the answer to these questions is positive or negative, economic criteria should be considered along with aesthetic criteria in determining which habitats and "listed" species deserve more research and more protective measures. We probably have the expertise to save and increase most or all of the "listed" species. But which should be increased? Economic evaluation is important in establishing priorities.

Duke and Terrell¹² list 1000 species in their Crop Diversification Matrix. Only 0.3% of those "crop" species are "listed," Juglans hindsii, Limnanthes bakeri, and a variety of Limnanthes douglasii. Cross checking the "listed" species with the WSSA list, we find only two "listed" species: Ceanothus cyaneus and Taxus floridana, on both lists. Although Taxus may be poisonous to cattle, many people, perhaps even the WSSA, would not consider it a weed. In the WSSA list, tree species are included which are not necessarily weeds. Perhaps their composite weed list contains some species which some of their contributors would not regard as weeds. Subtaxa of 14 other "weed" species are "listed", a subspecies of Artemisia cana, Stillingia sylvatica, and varieties of Cerastium arvense, Chrysothamnus nauseosus, Croton glandulosus, Erigeron pulchellus, Ilex opaca, Opuntia imbricata, Oryzopsis hymenoides, Persea borbonia, Quercus shumardii, Rhus trilobata, Rudbeckia triloba, and Sporobolus neglectus.

Some of the tallies in Table 1 surprise me. Usher seems to give more weight to obscure medicinal and ritual than to ornamental uses! I

would give Helianthus a positive score, since it contains 3 rather important vegetables, artichoke, sunchoke, and sunflower. Usher cites 13 species of Antirrhinum, the snapdragon genus, but H. M. Cathey, ¹³ suggests that the annual value of the snapdragon industry in the United States is in excess of 10 million dollars. I would give Antirrhinum a positive (useful) score, but Table 1 scores it neutral. Many of the grass genera (e.g., Digitaria) have more negative (weed) than positive (useful) species according to the Table, but I would give them a positive score because of their potential for fodder and forage.

With these reservations in mind, and remembering that a useful species is defined only as one cited by Usher, and a weed is defined only as one cited in one of four weed lists, I summarize the table. Of the more than 500 genera with "listed" species, only about 8% score strictly negative (on at least one weed list, no useful reports), 15% are strictly positive (some useful species, none on weed lists), 25% have more negative than positive scores, while 34% have more positive than negative species. The largest category, 41%, represents neutral genera, with as many useful species as show up on the weed lists. Three-fourths of the genera have positive or neutral scores, only one-fourth have negative scores. Without further study, I would give higher priority to the endangered species in strongly positive genera, lesser priority to the threatened species in strongly negative genera.

Footnotes

- Chief, Plant Taxonomy Laboratory, Plant Genetics and Germplasm Institute, Agricultural Research Service, Beltsville, Maryland 20705.
- Abraham Lincoln, as quoted by E. L. Knake, 1975. *Weed Science* 23(3): 252.
- Department of Interior, Fish and Wildlife Service. 1975. Threatened or Endangered Fauna or Flora. Review of Status of Vascular Plants and Determination of "Critical Habitat." Federal Register 40(127) Part V: 27824-27924.
- Biological Aids, Plant Taxonomy Laboratory.
- Usher, George. 1974. *A Dictionary of Plants Used by Man*. Constable and Co., Ltd. London. 619 pp.
- Clerk Typists, Plant Taxonomy Laboratory.
- WSSA (Weed Science Society of America) 1971. Composite List of Weeds. *Weed Science*. 19(4): 435-476.
- Research Botanists, Plant Taxonomy Laboratory.
- Botanist, Estacion Experimental La Lima, La Lima, Honduras.
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- ¹Chief, Medicinal Plant Resources Laboratory, Plant Genetics and Germplasm Institute, Agricultural Research Service, Beltsville, Maryland 20705. Information provided by Dr. A. S. Barclay of that Laboratory.
- ²Duke, J. A. and E. E. Terrell. 1974. Crop Diversification Matrix: Introduction. *Taxon* 23(5/6): 759-799.
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ABRONIA			BACOPA	1+ 3-	CHIONANTHUS	1+
ABUTILON	12+ 3-		BAHIA		CHLORIS	1+ 8-
ACACIA	76+ 10-		BALDUINA		CHLOROGALUM	1+ 1-
ACANTHOMINTHA			BALSAMORHIZA	3+	CHOISYA	
ACER	13+ 10-		BAPTISIA	3+ 1-	CHORIZANTHE	
ACLEISANTHES			BARTONIA		CHRYSOTHAMNUS	2+ 6-
ACONITUM	13+ 1-		BERBERIS	11+ 4-	CIMICIFUGA	2+
AGALINIS			BLENNOSPERMA		CIRSIIUM	9+ 15-
AGASTACHE	2+		BOLTONIA	1+	CLARKIA	
AGAVE	22+ 2-		BONAMIA		CLAYTONIA	5+
AGRIMONIA	1+ 3-		BOTHRIOCHLOA	2+ 1-	CLEMATIS	9+ 4-
AGROSTIS	2+ 4-		BOTRYCHIUM	1+	CLEOME	7+ 5-
ALETES			BRAYA		CLITORIA	3+ 1-
ALLIONIA		1-	BRAZORIA		COLLINSIA	1+ 1-
ALLIUM	27+ 8		BRICKELLIA	1+	COLLOMIA	1-
ALNUS	12+ 6-		BRODIAEA	1+	COLUBRINA	4+ 1-
AMBROSIA	6+ 6-		BROMUS	6+ 19-	COMMELINA	16-
AMOREUXIA			BRONGNIARTIA		CONDALIA	3+ 2-
AMORPHA	1+		BUCKLEYA		CONRADINA	
AMPLIANTHUS			BUMELIA	3+ 2-	CORDYLANTHUS	1+
AMINCKIA		3-	CACALIA	1-	COREOPSIS	2+ 1-
AMSONIA			CAESALPINIA	20+ 3-	CORYDALIS	4+ 1-
ANCISTROCACTUS			CALAMAGROSTIS	1-	CORYPHANTHA	
ANDRACHNE			CALAMINTHA	2+ 3-	COURSETIA	1+
ANDROPOGON	11+ 15-		CALAMOVILFA	1+	COWANIA	1+
ANEMONE	11+		CALLIANDRA	3+	CRATAEGUS	12+ 6-
ANGELICA	11+ 1-		CALLIRHOE	3+	CROOMIA	
ANTENNARIA		3-	CALOCHORTUS	5+	CROSSOSOMA	
ANTIHERICUM			CALYSTEGIA	1+	CROTON	24+ 9-
ANTIIRRHINUM			CAMASSIA	2+	CRYPTANTHA	
APIOS	1+ 1-		CAMISSONIA		CTENIUM	
AQUILEGIA	2+ 1-		CAMPANULA	3+ 2-	CUCURBITA	5+ 3-
ARABIS			CARDAMINE	4+ 3-	CUPHEA	1+ 2-
ARCEUTHOBIMUM			CAREX	12+ 19-	CUPRESSUS	8+
ARCTOMECON			CARPENTERIA		CUSCUTA	1+ 24-
ARCTOSTAPHYLOS	5+ 12-		CASSIA	32+ 17-	CYCLADENIA	
ARENARIA	2+ 1-		CASTANEA	7+ 2-	CYCLODON	
ARGEMONE	2+ 4-		CASTILLEJA	2-	CYMOPHYLLUS	
ARSYTHAMNIA			CAULANTHUS	1+	CYOPTERUS	5+ 1-
ARISTIDA	1+ 4-		CAULOSTRAMINA		CYPERUS	23+ 35-
ARNICA	2+		CEANOTHUS	2+ 13-	CYPRIPEDIUM	1+
ARTEMISIA	26+ 23-		CENTAURIUM	2+	DALEA	4+
ASCLEPIAS		17-	CENTROSEMA	2+ 3-	DARLINGTONIA	
ASIMINA	2+		CERASTIUM	1+ 3-	DASYNOTUS	
ASPLENIUM	2+ 1-		CEROCARPUS	3+ 3-	DELPHINIUM	7+ 13-
ASTER	2+ 14-		CEREUS		DESMODIUM	10+ 13-
ASTRAGALUS	32+ 24-		CHAENACTIS		DICENTRA	2+
ASTRANTHIUM			CHAIETOPAPPA		DICERANDRA	
ATRIPLEX	10+ 17-		CHAMAESYCE		DIGITARIA	10+ 21-
AUREOLARIA			CHEILANTHES	1+	DIONAEA	

DIPLACUS		GALACTIA	1+ 1-	HYMENOXYS	2-
DITAXIS	1+	GALINSOGA	1+ 2-	HYPERICUM	6+ 9-
DODECATHEON	1+	GALUM	2+ 9-	HYPOXIS	1+
DOUGLASIA		GAURA	6-	ILEX	20+ 5-
DRABA	1-	GAYA		ILLIAMNA	
DUDLEYA		GENISTIDIUM		ILLICIAM	3+
DYSCHORISTE		GENTIANA	5+ 1-	IPOMOEA	42-
DYSSODIA	1-	GEOCARPON		IRIS	11+ 3-
ECHEVERIA		GERANIUM	7+ 11-	ISOETES	1+
ECHINACEA	2+	GEUM	2+ 2-	ISOTRIA	
ECHINOCACTUS	1+	GILIA	2+	IVESIA	
ECHINOCEREUS	3+	GILMANIA		JACQUEMONTIA	1+ 2-
ELEOCHARIS	4+ 16-	GLAUCOCARPUM		JAMESIANTHUS	
ELLIOTTIA		GLYCERIA	1+ 6-	JUGLANS	14+ 3-
ELYTRARIA	1+	GNAPHALIUM	3+ 16-	JUNCUS	4+ 18-
ENCELIA	1+ 1-	GRAMMITIS		JUSTICIA	1+ 6-
ENCALIOPSIS		GRATIOLA	1+ 4-	KALMIA	1+ 3-
ENCYCLIA		GRINDELIA	2+ 1-	KOSTELETZKYA	1+ 1-
EPHEDRA	11+ 2-	GUTIERREZIA	1+ 4-	LACHNOCAULON	
EPILOBIUM	1+ 3-	GYMNOCARPIUM		LAPHAMIA	
EPITHELANTHA		GYMNOPOGON		LASTHENIA	
ERAGROSTIS	4+ 20-	HACKELIA	1-	LATHYRUS	15+ 12-
ERLASTRUM		HALIMOLOBOS		LAVATERA	2+ 2-
ERIGERON	2+ 8-	HAPLOPAPPUS	2+ 5-	LAYIA	
ERIOCAULON	4-	HARPEROCALLIS		LEAVENWORTHIA	
ERIOCHLOA	2+ 2-	HARTWRIGHTIA		LECHEA	
ERIODICTYON	2+	HEDEOMA	1+ 1-	LEGENERE	
ERIOGONUM	4+ 1-	HEIMIA		LEPANTHOPSIS	
ERIOPHYLLUM		HELENIUM	2+ 5-	LEPIDIUM	6+ 11-
ERRAZURIZIA		HELIANTHELLA		LEPTODACTYLON	
ERYNGIUM	12+ 11-	HELIANTHEMUM	1+	LESPEDEZA	4+ 5-
ERYSIMUM	1+ 4-	HELIANTHUS	6+ 7-	LESQUERELLA	1-
ERYTHRONIUM	3+	HELIOTROPIMUM	4+ 18-	LEWISIA	1+
ESCHSCHOLZIA	1+ 1-	HEMIZONIA	1-	LIATRIS	3+
EUPATORIUM	14+ 15-	HESPEROLINON		LILIUM	20+
EUPHORBIA	36+ 37-	HETEROTHECA	1-	LIMNANTHES	
EURYTAENIA		HEUCHERA		LIMONIUM	1+
EUTREMA	1+	HEXALECTRIS		LIMOSELLA	
FEROCACTUS	2+	HEXASTYLIS		LINANTHUS	
FESTUCA	5+ 5-	HIBISCUS	17+ 6-	LINDERA	3+ 1-
FILIPENDULA	1+	HIERACIUM	1+ 7-	LINDERNIA	1+ 6-
FIMBRISTYLIS	3+ 9-	HOFFMANNSEGGIA	1+ 1-	LINUM	5+ 7-
FORESTIERA	1+ 3-	HOLOCARPHA		LISTERA	
FORSELLESIA		HORKELIA		LITSEA	8+
FOTHERGILLA		HOUSTONIA		LOMATIUM	5+ 1-
FRANKENIA	4+	HUDSONIA		LOTUS	1+ 5-
FRASERA	1+	HULSEA		LUINA	
FRAXINUS	11+ 8-	HYDROPHYLLUM	3+	LUPINUS	5+ 11-
FREMONTODENDRON	1+	HYMENOCALLIS	1+ 1-	LYCIUM	8+ 6-
FRITILLARIA	5+	HYMENOPAPPUS	2+	LYONOTHAMNUS	

LYTHRUM	1+	5-	OXYTROPIS	5-	PRENANTHES	2+
MACBRIDEA			PANICUM	21+	PRIMULA	3+
MACHAERANTHERA	2+		PAPAVER	3+	PROBOSCIDEA	1-
MAGNOLIA	10+		PARNASSIA		PRUNUS	32+
MALACOTHAMNUS			PARONYCHIA	2+	PSEUDOBABIA	10-
MALACOTHRIX			PARRYA		PSORALEA	8+
MAMILLARIA		1-	PARTHENIUM	3+	PTILIMNIUM	3-
MANIHOT	7+	1-	PARVISEDUM		PUCCINELLIA	1+
MANISURIS			PECTIS	2+	PYCHANthemUM	3-
MARGARANTHUS			PEDICULARIS	2+	PYXIDANTHERA	
MARSHALLIA			PEDIOCACTUS		QUERCUS	60+
MATELEA			PENSTEMON	1+	RAILLARDELLA	45-
MAURANDYA			PENTACHAETA		RANUNCULUS	5+
MELANTHERA			PERIDERIDIA		RHAPIDOPHYLLUM	20-
MENTZELIA	1+	1-	PERITYLE		RHEXIA	
MERTENSIA	1+		PERSEA	6+	RHINANTHUS	5-
MICRANTHEMUM			PERSICARIA		RHODODENDRON	4+
MICROSERIS			PETALONYX		RHUS	6-
MIMULUS			PETALOSTEMUM	2+	RHYNCHOSIA	21+
MIRABILIS	1+		PETERIA		RHYNCHOSPORA	14-
MONARDA	3+		PETROPHYTUM		RHYSOPTERUS	1-
MONARDELLA	1+		PHACELIA	1+	RIBES	14+
MONOTROPIS			PHILADELPHUS	1+	RORIPPA	27-
MUHLENBERGIA	1+	4-	PHIPPSIA		ROSA	6-
MULLA			PHLOX	1+	ROYSTONEA	11+
MYRCIANTHES			PHYLLANTHUS		RUBUS	10-
MYRIOPHYLLUM		5-	PHYLLITIS		RUBUS	2+
NAMA		1-	PHYSARIA		RUBBECKIA	40+
NAVARRETIA		2-	PHYSOSTEGIA	1+	RUPELLIA	19-
NEMAELADUS			PIERIS	1-	RUELLIA	5-
NEMASTY			PINCKNEYA	1+	RUMEX	2-
NEOLLOYDIA			PINGUICULA	1+	SAGITTARIA	17+
NEOPARRYA			PITYOPUS		SALIX	2+
NEOSTAPFIA			PLAGIOBOTHRYUS		SALVIA	19+
NESTRONIA			PLATANThERA	1+	SANICULA	14-
NEVIUSIA			PLEUROPOGON		SARRACENIA	2+
NITROPHILA			PLUMMERA		SATUREJA	5+
NOLINA	3+	2-	POA	11+	SAXIFRAGA	3+
NOTHOLAENA			POGONYNE	1+	SCHISANDRA	
NUPHAR	3+		POLEMONIUM	2+	SCHIZACHYRUM	1-
OENOTHERA	1+	6-	POLIANThES	1+	SCHIZAEA	
ONOSMODIUM			POLYGALA	1+	SCHOENOLIRION	
OPHIOGLOSSUM	4+		POLYGONELLA	17+	SCIRPUS	9+
OPUNTIA	19+	14-	POLYGONUM	17+	SCLEROCACTUS	17-
ORCUTTIA			POLYSTICHUM		SCROPHULARIA	2+
ORBANChE	4+	3-	POPULUS	13+	SCUTELLARIA	2+
ORITHOCARPUS			POROPHYLLUM		SEDUM	7+
ORYZOPSIS	1+	1-	PORTULACA	5+	SELENIA	5-
OSTRYA	3+	1-	POTAMOGETON	1+	SENECIO	14+
OXYPOLIS			POTENTILLA	9+	SHORTIA	24-
					SIBARA	1-
					SIDA	4+
						12-

SIDALCEA		TRAGIA	1-
SILENE	3+ 11-	TRICHOSTEMA	1-
SILPHIUM	2+ 1-	TRIFOLIUM	24+ 12-
SISYMBRIUM	3+ 11-	TRILLIUM	2+
SIUM	3+ 2-	TRIPHORA	1-
SMELOWSKIA		TRIPSACUM	2+ 2-
SMILAX	20+ 7-	TRITELEIA	
SOLANUM	42+ 30-	TROLLIUS	
SOLIDAGO	10+	TROPIDOCARPUM	
SOPHORA	8+ 9-	URTICA	9+ 7-
SPHAERALCEA	1+ 4-	VACCINIUM	19+ 8-
SPHENOSTIGMA		VALERIANA	5+
SPIGELIA	4+ 2-	VANCOUVERIA	
SPIRANTHES	1+	VANQUELINIA	
SPOROBOLUS	4+ 10-	VERATRUM	3+ 4-
STACHYS	5+ 7-	VERBENA	2+ 7-
STEIRONEMA		VERBESINA	2+ 2-
STELLARIA	1+ 3-	VERNONIA	12+ 7-
STENANDRIUM		VERONICA	4+ 17-
STEPHANOMERIA	1-	VIBURNUM	6+ 7-
STILLINGIA	1+ 1-	VICIA	15+ 13-
STIPA	6+ 11-	VIGUIERA	2-
STREPTANTHUS		VIOLA	5+ 10-
STYRAX	7+	WALDSTEINIA	
SUAEDA	2-	WAREA	
SULLIVANTIA		WILLKOMNIA	
SWALLENIA		WOODSIA	
SYMPHORICARPOS	1+ 3-	WYETHIA	2+ 1-
SYNANDRA		XYRIS	4+
SYNTHYRIS		ZAMIA	4+
TAGETES	4+ 1-	ZANTHOXYLLUM	16+ 3-
TALINUM	4+ 3-	ZEPHYRANTHES	1+ 1-
TANACETUM	1+ 2-	ZIZANIA	2+ 2-
TARAXACUM	3+ 7-	ZIZIA	
TAUSCHIA			
TAXUS	4+ 2-		
TECTARIA	2+		
TEPHROSIA	9+ 1-		
TETRACOCCLUS			
THALICTRUM	5+ 2-		
THELOCACTUS			
THELYPODIUM			
THERMOPSIS	1+ 2-		
THLASPI	1+ 2-		
THYSANOCARPUS			
TOFIELDIA			
TORREYA	3+ 1-		
TOWNSENDIA			
TRACYNIA			
TRADESCANTIA	1+ 3-		

Table 1. Economic Evaluation of Genera with Endangered or Threatened Species (____+, number of useful species listed in Usher, ____-, number of weed species in composite weed list compiled in Plant Taxonomy Laboratory.